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(71) Applicant: **The BOC Group plc**
Windlesham Surrey GU20 6HJ (GB)

(72) Inventors:
- **Dovey, Stephen James**
  West Chiltington, West Sussex RH20 2PW (GB)
- **Shelley, Gerald Robin**
  Framfield, East Sussex TN22 5NS (GB)
- **Stones, Ian David**
  West Sussex RH15 8UU (GB)

(74) Representative: **Bousfield, Roger James et al**
The BOC Group plc
Chertsey Road
Windlesham Surrey GU20 6HJ (GB)

(54) Piston stroke control for a vacuum pump

(57) A machine, for example, a vacuum pump 1 comprises a cylinder closed at both ends in which is mounted a reciprocating piston 5. Means is provided for driving the piston 5 and a vibration sensor 3 is provided for sensing any contact between the piston 5 and said ends.

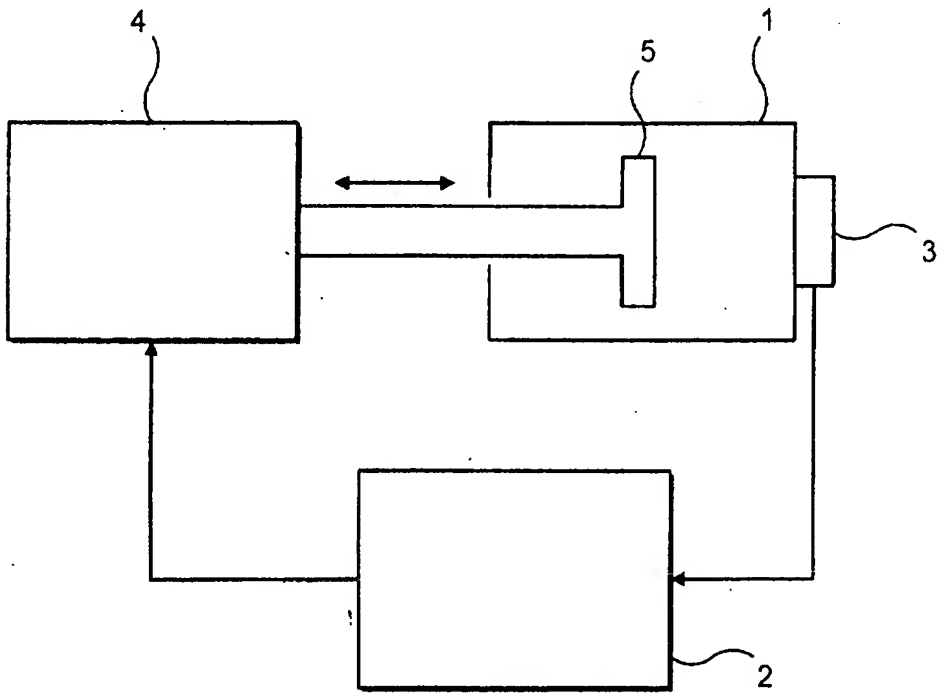

FIG.1

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Description

[0001] The present invention relates to reciprocating machines and, more particularly, to vacuum pumps which incorporate a reciprocating piston.

[0002] Vacuum pumps incorporating a reciprocating piston mode of operation are known which have an electromagnetic actuator arrangement driving a piston.

[0003] In European patent publication no. 0793019 there is described a vacuum pump which uses a multi-stage reciprocating piston mode of operation in which piston reciprocation is effected by electromagnetic drive means and a counter-acting spring means and in which the pump stages are connected in series between a pump inlet and a pump outlet such that, in use, gas being transferred through the pump passes through the stages in turn.

[0004] It is an aim of the present invention to provide a machine and more particularly a vacuum pump incorporating a reciprocating piston in which a vibration sensor is used to control the piston stroke and thus avoid over driving the machine/vacuum pump.

[0005] According to the present invention, a machine comprises a cylinder closed at both ends, a piston mounted for reciprocable movement within the cylinder between each end, means for driving the piston and a vibration sensor for sensing any contact between the piston and said ends.

[0006] In a preferred embodiment the machine is a vacuum pump, the vibration sensor is a piezoelectric device and the driving means includes an electro-magnet.

[0007] Preferably, the machine is driven be a closed loop control including the vibration sensor, a variable drive and an electronic circuit which is used to analyse the vibration sensor output signal to determine the drive voltage.

[0008] An embodiment of the invention will now be described, by way of example reference being made to the Figure of the accompanying diagrammatic drawing which is a schematic illustrating the relationship between the drive means, reciprocating piston, vibration sensor and controller of a machine according to the present invention.

[0009] As shown a vibration sensor 3 for example a piezoelectric device is mounted on a machine in the form of a pump 1, such that any end collision of reciprocation piston 5 is detected, for example on the end of the pump. Vibration sensor 3 is electrically/electronically connected to a controller 2 in the form of an electronic circuit, for example a micro-processor. In turn, the controller 2 is electrically/electronically linked to a variable voltage drive means 4 including an electromagnet which is itself mechanically linked to the piston 5 of the pump 1, to form a closed loop control system.

[0010] In use, the controller 2 is set to deliver a gradually increasing voltage across the drive means 4. This has the effect of gradually increasing the stroke length of the piston 5. Should the end of the piston 5 strike an end plate (not shown) at either end of the pump 1 this is detected by the vibration sensor 3 which generates a signal which is transmitted to the controller 2. Receipt of said signal from the vibration sensor 3 then causes the controller 2 to reduce the drive voltage to the drive means 4.

[0011] It will be apparent that, in the above described embodiment, the pump 1 is driven by a closed loop control system which includes a vibration sensor 3, a variable drive means 4 and a controller 2 which is used to analyse the sensor output to determine the drive voltage.

[0012] The vibration sensor 3 is effectively used to maximise the piston stroke by sensing any end point engagement and thereby avoiding over driving the pump. The vibration sensor 3 is able to detect collision at either end, therefore the maximum stroke is achleved Independent of any offsets In the system.

[0013] Although reference is made in the above described embodiment to a variable voltage drive means, said drive means could be a variable current drive.

[0014] The benefits of the control means are:

- optimum performance of the machine is achieved through maximised stroke length.
- the closed loop control provides inherent compensation for mechanical load and power supply variations.
- the vibration sensor 3 is not intrusive, therefore not vulnerable to contamination or corrosive attach.
- the vibration sensor 3 does not require accurate calibration or positioning indeed the sensor may be mounted on any appropriate surface of the machine.
- the electronic controller may detect vibration sensor failure or detachment by monitoring the background vibration level from the sensor 3.
- the closed look control provides inherent compensation for change in mechanical performance over time.
- The closed loop control requires minimal set up in manufacture and service.

Claims

1. A machine comprising a cylinder closed at both ends, a piston mounted for reciprocable movement within the cylinder towards and away from said ends, means for driving the piston and a vibration sensor for sensing any contact between the piston and said ends.

2. A machine as claimed in Claim 1, in which the driving means is a variable voltage or current drive means controlled by signals from a controller.

3. A machine as claimed in Claim 2, in which the vibration sensor, the controller and the variable voltage/current drive means define a closed loop control system.

4. A machine as claimed in Claims 1 or Claim 2 or Claim 3, in which the vibration sensor is mounted on the machine adjacent a closed end, such that it is not invasive to the internal operation of the machine.

5. A machine as claimed in any one of Claims 1 to 4 in the form of a vacuum pump.

6. A machine constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the Figure of the accompanying drawing.

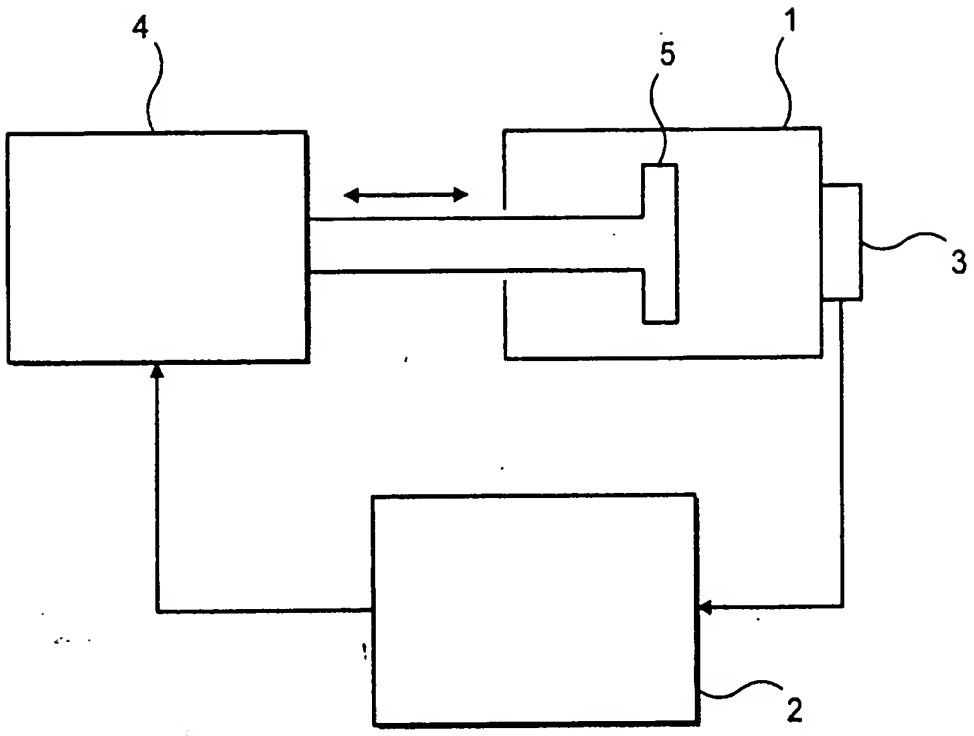

FIG.1